

## VIBRATION ISOLATION MEMBER

### Field of the Invention

[0001] The invention relates to a vibration isolation member and more particularly the invention relates to a vibration isolation member that provides substantially equal dynamic stiffness in radial and axial directions and comprises an outer member with an inner periphery, an inner member with an outer periphery and a resilient member joining the inner and outer members wherein the dimensions of the inner and outer peripheries provide for an interference therebetween in the event of a failure of the elastomer.

### Background of the Invention

[0002] Vibration isolation members are frequently used in aircraft interior applications to reduce the vibration and noise exposure to delicate and sensitive instrumentation and also to passengers in the aircraft cabin. In aircraft applications the vibration isolation members must provide the requisite vibration reduction with a minimum size and weight vibration isolation member.

[0003] One means for effectively reducing such exposure to noise and vibration is to use a vibration isolation member that has iso-elastic stiffness properties. A vibration member that is iso-elastic has equal stiffness in the axial and radial directions. Iso-elastic stiffness permits the vibration isolator to provide dependable performance in any orientation and maximize vibration reduction for a given installation. A vibration isolation member that does not provide such iso-elastic

stiffness properties will transmit vibration more efficiently in one or more directions, compared to an iso-elastic vibration member having the same minimum stiffness.

**[0004]** Additionally, it is desirable to include a mount fail-safe feature that

5 prevents the mount from separating in the event the mount fails under loading.

Several prior art mounts provide fail safe features that function in a single axial direction however, such prior art mounts typically do not have two fail safe paths.

Moreover, in vibration isolation members that comprise iso-elastic members, the members frequently do not have a fail-safe or interference path that is defined by the

10 components that comprise the mount. Rather the fail-safe feature is produced by adding washers or other discrete mechanical members to the member. The additional components required to provide a fail safe feature in an iso-elastic vibration isolation member add weight and increase the volume required to house the member in the aircraft.

15

**[0005]** The foregoing illustrates limitations known to exist in present devices

and methods. Thus, it is apparent that it would be advantageous to provide a vibration

isolator that provides iso-elastic stiffness in combination with fail safe feature and

thereby solves one or more of the shortcomings of present isolation devices and

20 methods. Accordingly, a suitable vibration isolation member is provided including

features more fully disclosed hereinafter.

### Summary of the Invention

**[0006]** In one aspect of the present invention this is accomplished by

5 providing a vibration isolation member that provides iso-elastic stiffness and at least one fail-safe feature.

**[0007]** More specifically the vibration isolation member of the present

invention comprises an inner member comprising an outer periphery having a first

10 dimension; an outer member comprising a base and a shroud that extends away from the base, the shroud adapted to overlay the inner member, said shroud defining an inner periphery having a second dimension, the second dimension being less than the first dimension; and a resilient member constrained between the shroud and the inner member, whereby the vibration isolation member provides iso-elastic stiffness and an 15 interference between the inner and outer members in the event of a failure of the resilient member.

**[0008]** The inner member is unitary and is comprised of a stem and a seat

where the seat includes a first surface, a second surface spaced from the first surface

20 and a third surface that joins the first and second surfaces. The third surface is oriented at an angle relative to the first surface. The seat has a frustoconical configuration.

**[0009]** The outer member shroud may comprise a single segment or may

25 comprise a first segment, a second segment and a third segment, the second segment joining the first and third segments. The outer member first segment is oriented substantially axially, the third segment is oriented substantially radially and the second segment is oriented at an angle relative to the first and second segments. The third surface of the seat is substantially parallel to the second segment of the shroud.

[0010] The foregoing and other aspects will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawing figures.

5

#### **Brief Description of the Drawings**

[0011] Figure 1 is an isometric view of the vibration isolation member of the present invention.

10

[0012] Figure 2 is a top view of the vibration isolation member of Figure 1.

[0013] Figure 3 is a longitudinal sectional view taken along line 3--3 of Figure 2.

15

[0014] Figure 4 is a longitudinal sectional view like the sectional view of Figure 3 illustrating a second embodiment vibration isolation member of the present invention.

20

[0015] Figure 5 is a longitudinal sectional view like the sectional view of Figure 3 illustrating third embodiment vibration isolation member of the present invention.

#### **Detailed Description of the Preferred Embodiment**

25

[0016] Turning to the drawing Figures wherein like parts are referred to by the same numbers in the Figures, the first embodiment vibration isolation member 10 of the present invention is disclosed in Figures 1, 2 and 3.

30

[0017] Generally, vibration isolation member 10 comprises an inner member 12, an outer member 14 and a resilient member 16 that joins the inner and outer members. The resilient member is constrained between the inner and outer members.

The inner and outer members 12 and 14 are relatively rigid. The vibration isolation member 10 is made from a conventional molding process well known to those skilled in the art and during the molding process the resilient member is bonded to the inner and outer members. The resilient member 16 may be comprised of any suitable

5 material however for purposes of the preferred embodiment of the invention the resilient member is comprised of a silicone or a synthetic rubber.

[0018] As shown in the sectional view of Figure 3, the isolator is adapted to be connected between a support structure 18 such as an aircraft frame for example, and a

10 suspended body 20 which may be an interior aircraft instrument or trim panel. The isolator 10 of the present invention reduces the transmission of vibratory disturbances, which may be in the form of acoustic noise, between the support structure 18 and the suspended body 20. The isolator also limits heat transfer between body 20 and structure 18. Also shown in Figure 3, the isolation member is joined to the suspended body 20 by conventional fastener 22 that extends between the body 20 and inner member 12; and is joined to the support structure 18 by fasteners 24a, 24b that extend through the outer member 14. The fasteners may be comprised of any suitable fastener well known to those skilled in the art including, but not limited to screws or quick - connect fasteners. By these connections, the outer member 14 remains

15 substantially stationary during use and the inner member 12 may be displaced in radial and axial directions represented by respective directional arrows 25 and 26.

20

[0019] The relatively rigid inner member 12 is unitary and comprises an axially extending cylindrical stem 30 and frustoconical seat 32. As shown in Figure 3, the seat includes first and second faces 34 and 36 joined by angled surface 38 that extends outwardly from face 34 to face 36. The surface 38 may extend at any suitable angle,  $\Theta$  relative to face 34. For purposes of describing the preferred embodiment of the invention, the angle may be about  $55^\circ$ . The stem is made integral with the seat 32 at face 34 and the free end of the stem extends outwardly from the opening in the

25 outer member 14 defined by inner periphery 62. Faces 34 and 36 are circular, planar members that join the surface 38 at respective outer edges. The inner member

30 includes an axially extending bore 40 that extends through the stem and seat and is

adapted to receive fastener 22 previously described above. The seat defines an outer periphery 42 that comprises a diameter,  $D'$ . The extent of the inner member outer periphery 42 is also represented in dashed font in Figure 2. As shown in Figure 3, when the member 10 is installed the seat is located proximate the support member 18.

5 Additionally, as shown in Figure 3, the surface 36 is located a distance away from the support structure 18 to allow for displacement of inner member 12 when the isolation member 10 experiences a vibratory disturbance.

**[0020]** The relatively rigid outer member 14 is unitary and comprises a substantially planar flange or base 50 with bores 52a and 52b that are adapted to receive fasteners 24a and 24b as described hereinabove. The base 50 is made integral with an annular shroud 54 that overlays seat 32. The shroud comprises a first segment 56 that extends in the axial direction defined by arrow 26, a second segment 58 that extends substantially parallel to surface 38, and a third segment 60 that extends in the radial direction defined by arrow 25. The second segment 58 joins the first and third segments 56 and 60. See Figure 3. Although the second segment is shown at an orientation that is substantially parallel to surface 38 it should be understood that although such a parallel configuration is preferred the second segment could be oriented at any relative angle and do not have to be parallel.

20

**[0021]** Third segment 60 terminates at inner periphery 62 that defines diameter,  $D''$ . As shown in Figures 2 and 3, the outer periphery 42 has a diameter  $D'$  that has a greater radial dimension than inner periphery 62 diameter,  $D''$ . In the event that resilient section fails, and the seat is displaced axially toward panel 20, an interference or fail-safe load path would be created between the seat and the segment 60 preventing further displacement of seat outward from the outer member. Thus the inner member would be captured by the outer member. As shown most clearly in the sectional view of Figure 3, to ensure that the desired interference is produced between the seat and shroud, the inner periphery 62 must terminate radially inwardly from the outer periphery 42.

[0022] During molding, resilient member 16 is bonded to the surface 38 and also to the inner surface of second segment 58. Additionally, the molding process produces relatively thin skin segments bonded along the inner surface of third segment 60 and inner periphery 62, stem 30 and surface 34, outer periphery 42 and along 5 portions of the inner surfaces of flange 50 and first segment 56. Apart from the skins, the main portion of the resilient member 16 has a substantially trapezoidal cross section.

[0023] The vibration isolation member 10 of the present invention provides 10 iso-elastic stiffness. The term “iso-elastic” means that the isolation member 10 has substantially the same stiffness in the axial and radial directions for any applied load. Because the resilient member 16 is constrained between the inner member 12 and outer member 14 the resilient member 16 experiences combined shear loads and loads in either tension or compression regardless of the direction and magnitude of the load 15 applied to the vibration isolation member 10.

[0024] The vibration isolation member 10 of the present invention provides a double fail safe feature that captures the inner member and maintains it in the chamber 80 defined by the outer member and the support structure 18. Failure of the elastomer 20 member 16 or failure of the bonds between member 16 and either inner member 12 or outer member 14 will not permit the inner member to relocate outside of the outer member. The inner member is captured by either the structural panel 18 or by the interference between the seat and segment 60 as described hereinabove. Therefore, in order for the inner member seat to become displaced from the chamber 80, failure of 25 the inner member, outer member fasteners or structural member must occur in addition to the resilient member failure. Additionally, in the event the resilient member 16 fails the seat will not be displaced out of chamber 80. The suspended body 20 will engage the rigid outer member while the seat will interfere with the inner member. Additionally, the structural member will impede additional axial 30 displacement of the seat towards member 20. In this way, the mount of the present invention provides double fail-safe feature in combination with its iso-elastic stiffness.

[0025] A second preferred embodiment vibration isolation member 70 is shown in Figure 4. The alternate embodiment mount 70 includes relatively rigid inner member 72 comprises stem 30 and seat 32 which defines angled surface 38. The stem 30, seat 32 and surface 38 as well as the other components and features are the same as those described hereinabove in conjunction with first embodiment vibration isolation member 10. In the second embodiment mount 70, the stem 30 and seat 32 may be made directly integral. The inner member 72 does not include surface 34 joining the stem and seat. The second embodiment member 70 includes the double fail-safe feature and also includes an iso-elastic stiffness.

10

[0026] A third preferred embodiment vibration isolation member 75 is illustrated in Figure 5. The alternate embodiment mount 75 includes relatively rigid outer member 76 with shroud 78. As shown in Figure 5, the shroud member is comprised of a hollow cone with a wall comprised of a single angled segment, that terminates at an inner periphery 62. As described in conjunction with first embodiment isolation member 10, the inner periphery 62 has a diameter  $D''$  that is less than the diameter  $D'$  of the outer periphery 42 of the seat 32. The other components and features of member 75 are the same as those described hereinabove in conjunction with first embodiment vibration isolation member 10. The third embodiment member 70 includes the double fail-safe feature and also includes an iso-elastic stiffness.

[0027] It should be understood the use of outer member 76 and inner member 72 are not limited to the isolation members shown in their respective embodiments but rather, outer member 76 may be combined with inner member 72 if desired.

[0028] While I have illustrated and described a preferred embodiment of my invention, it is understood that this is capable of modification, and I therefore do not wish to be limited to the precise details set forth, but desire to avail myself of such changes and alterations as fall within the purview of the following claims.